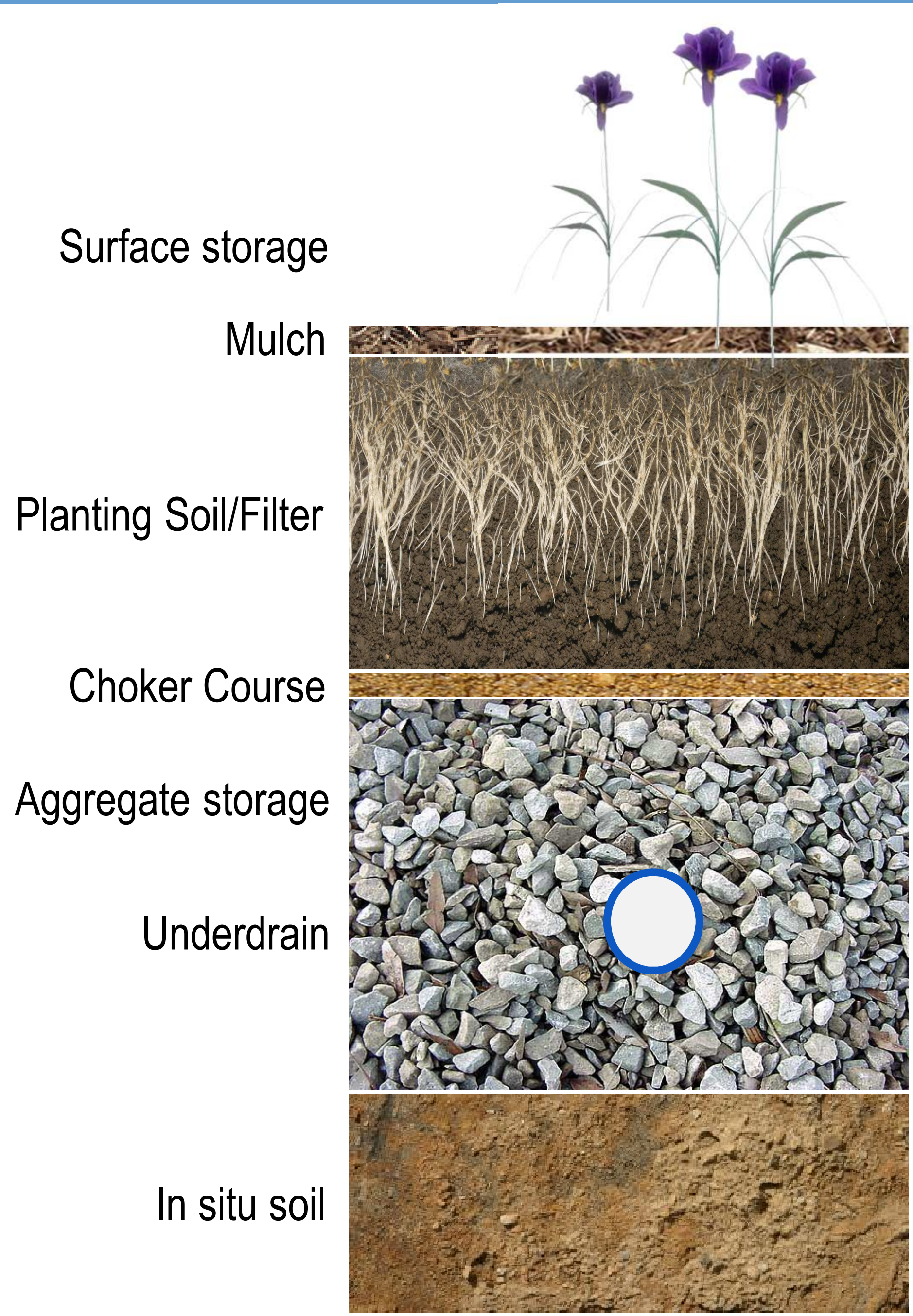
BIORETENTION

June 4, 2015

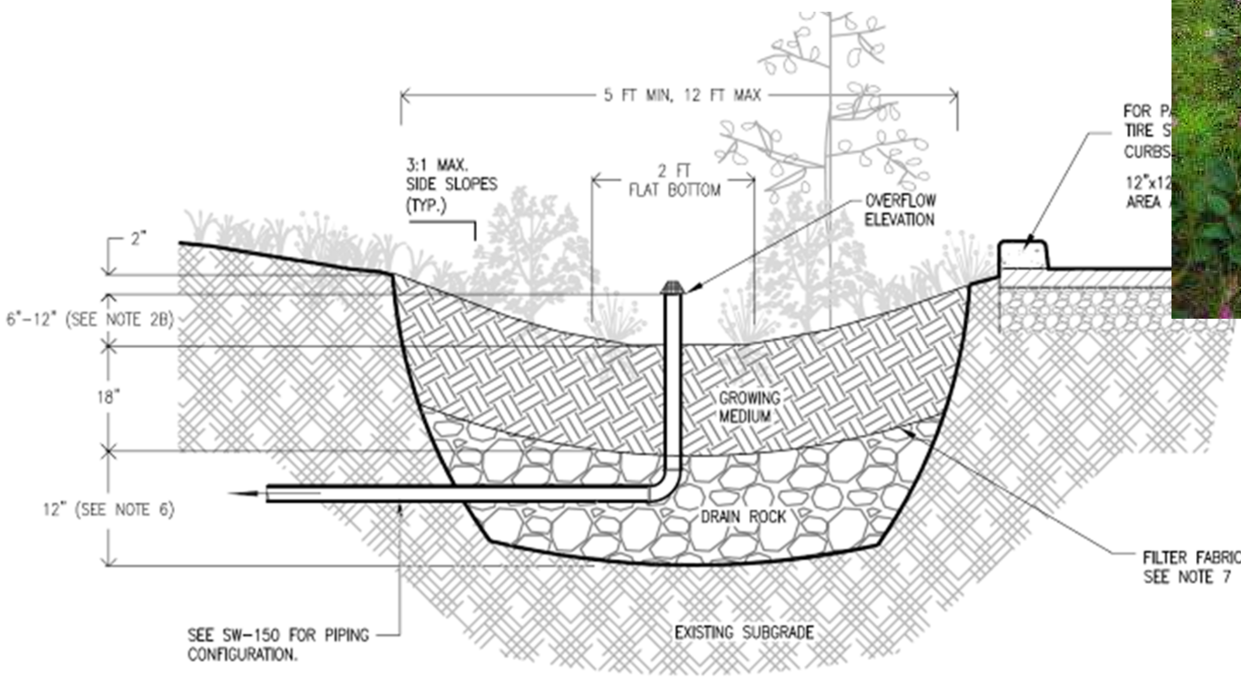
TYPICAL CROSS SECTION EXAMPLE APPLICATIONS

Let’s take a quick look at the typical components of a bioretention system and example cross sections

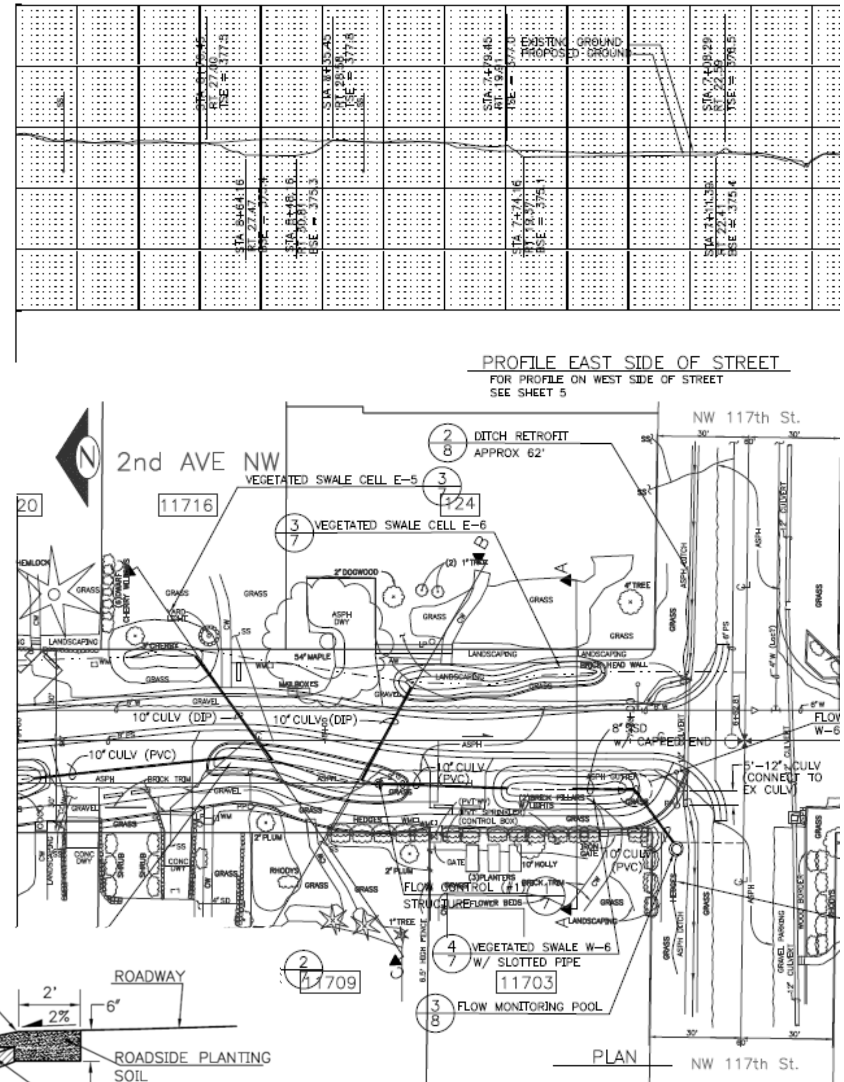
Bioretention

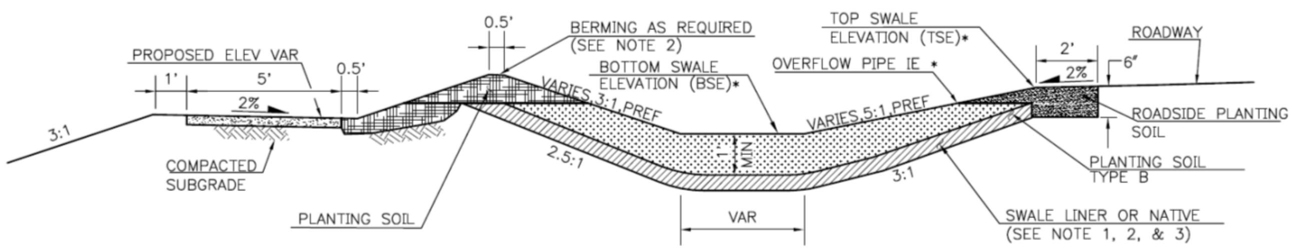


Swale - Small


5 FT MIN, 12 FT MAX
3:1 MAX.
SIDE SLOPES
(TYP.)
2 FT
FLAT BOTTOM
OVERFLOW
ELEVATION
2"
6"-12" (SEE NOTE 2B)
18"
12" (SEE NOTE 6)
GROWING
MEDIUM
DRAIN ROCK
FILTER FABRIC,
SEE NOTE 7
SEE SW-150 FOR PIPING
CONFIGURATION.
EXISTING SUBGRADE

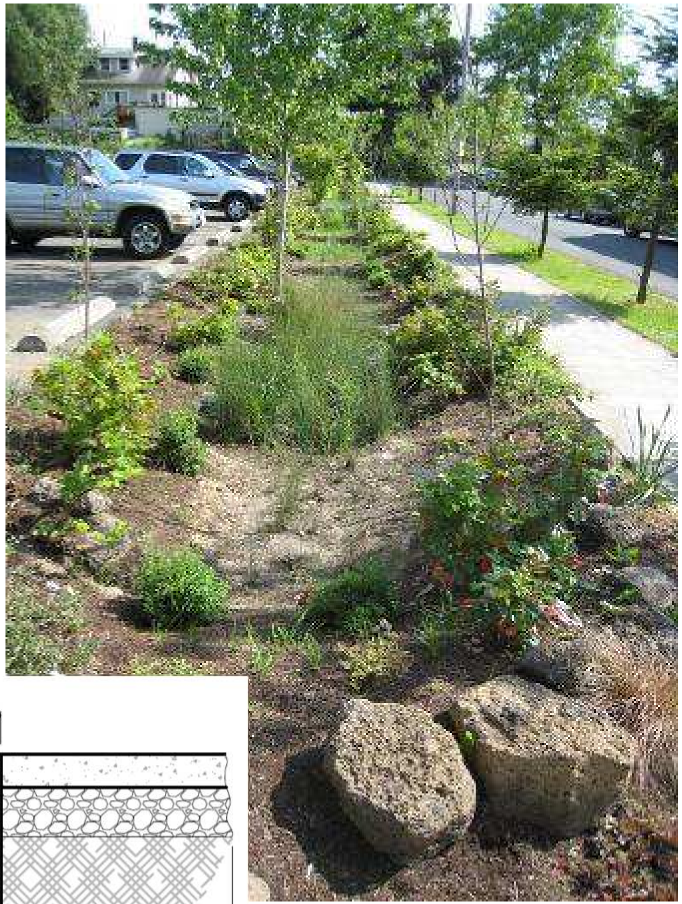
Swale - Large

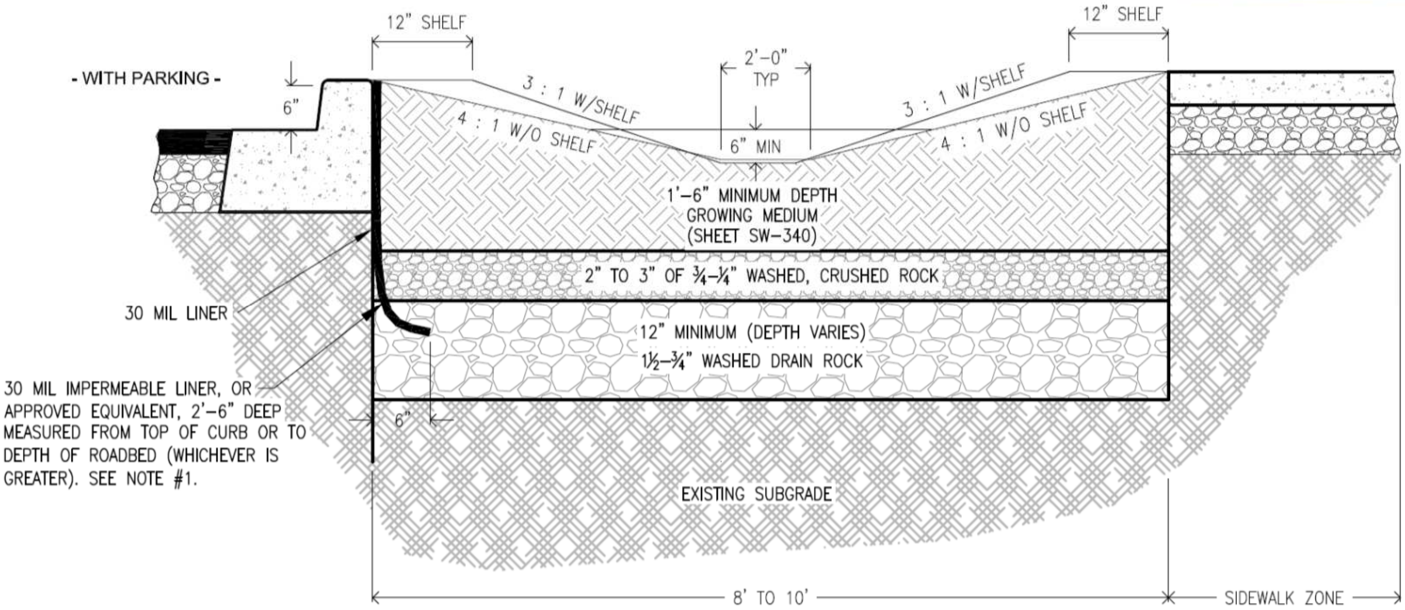




CROSS–SECTION VEGETATED SWALE (TYP) 3 / 3,4
SCALE: 3/8" = 1'–0"

Parking Lot Swale

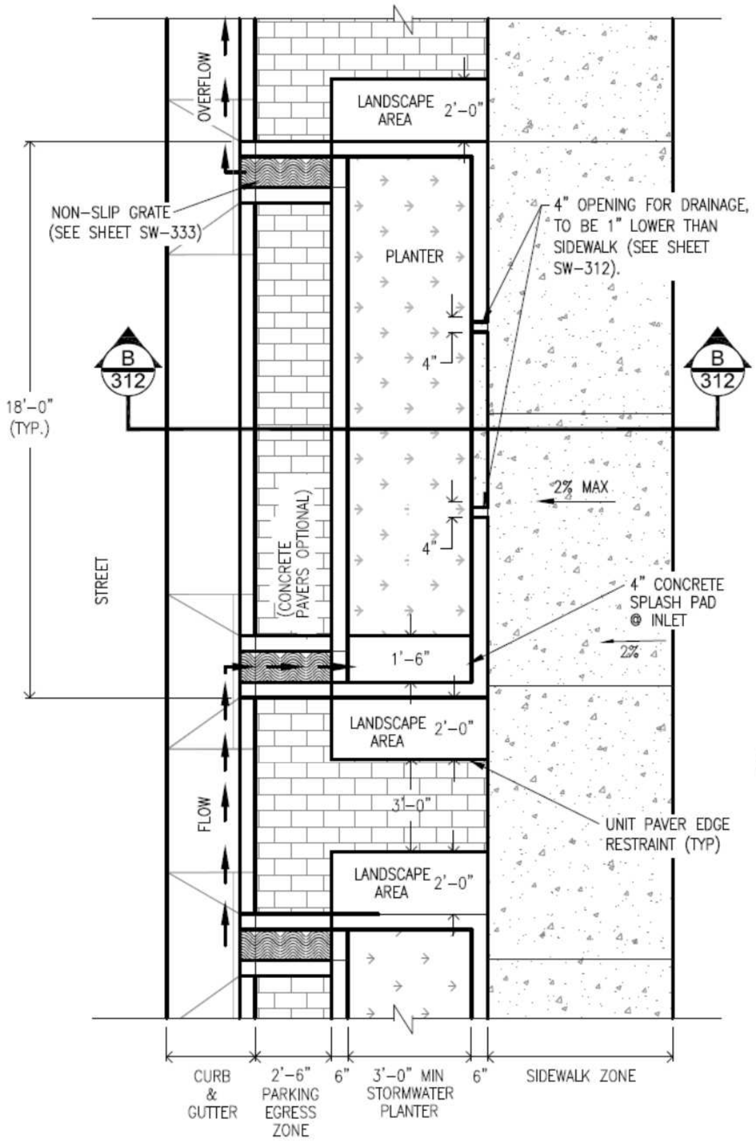


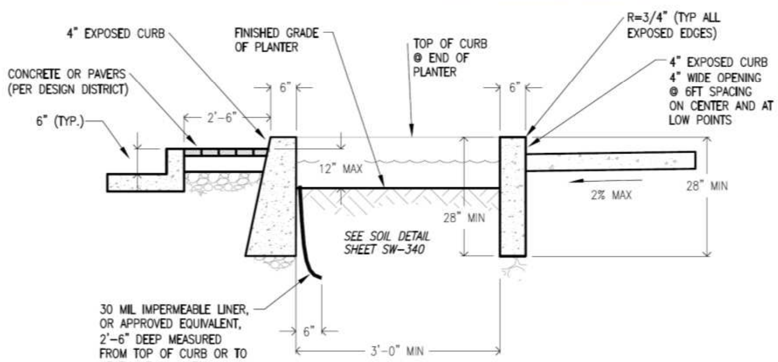


Bioretention Parking Lots

Bioretention at Building Sites

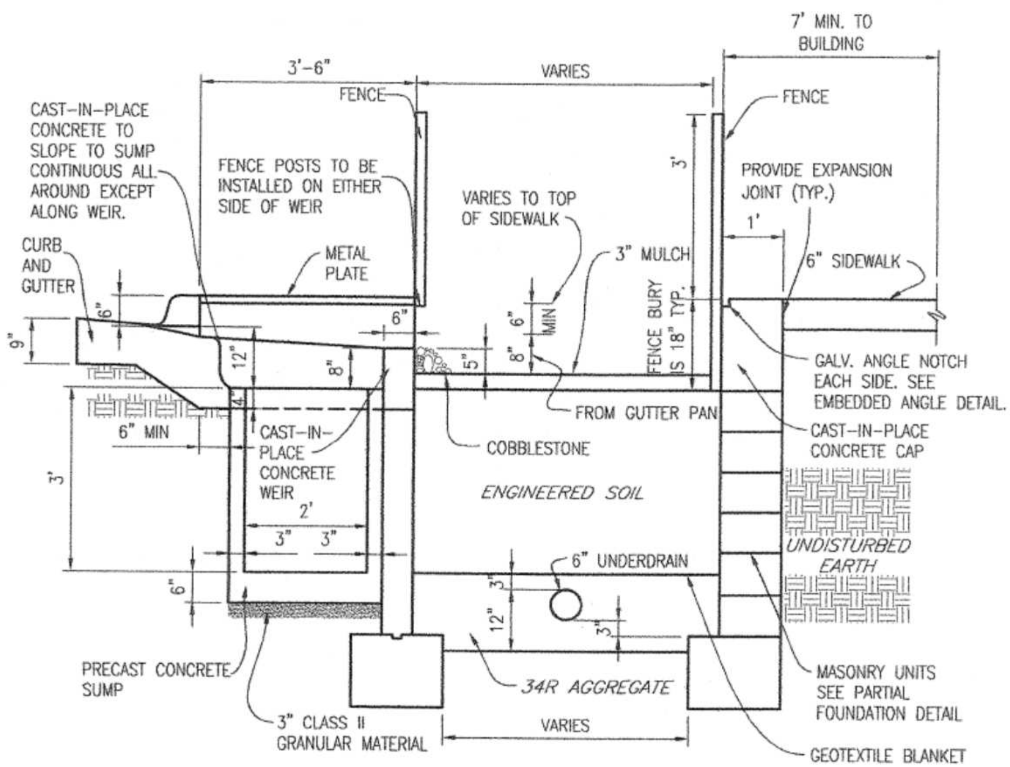
Linear Planter - Small



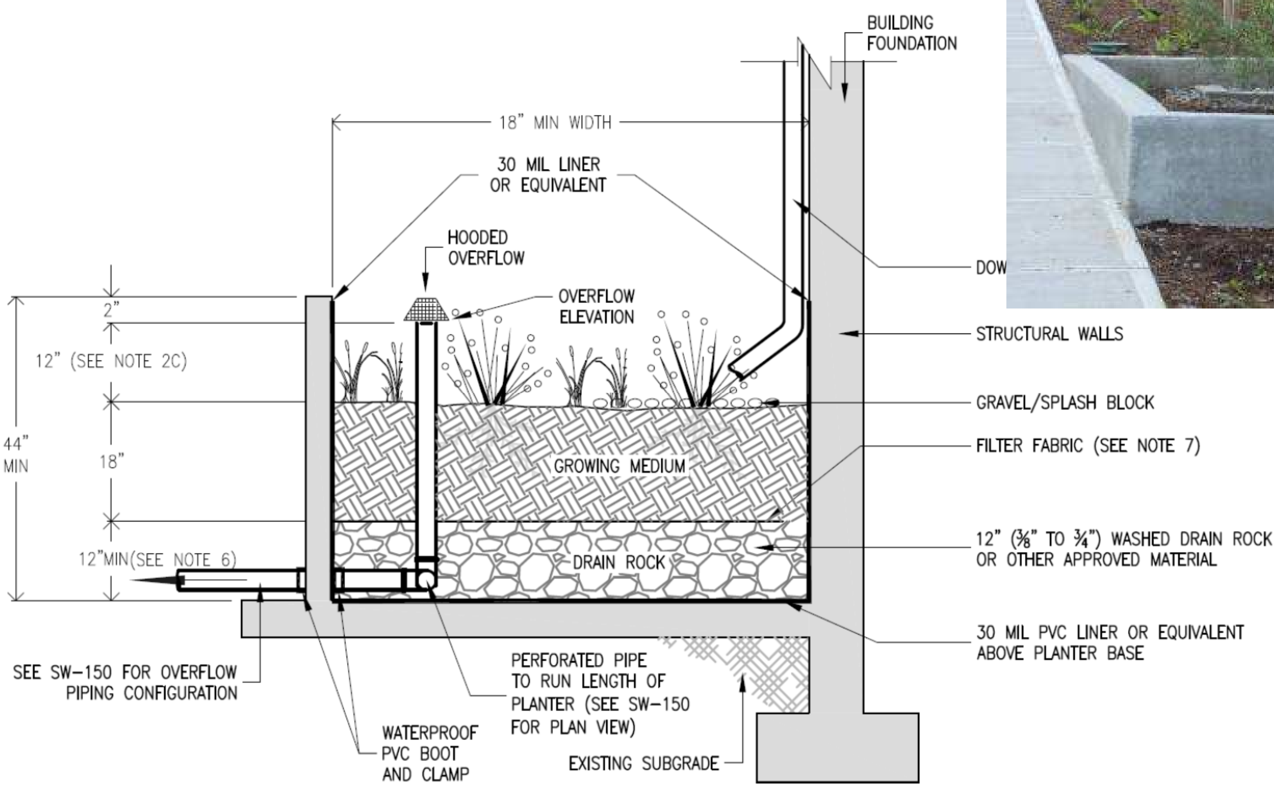


SECTION B-B
PLANTER WITH PARKING

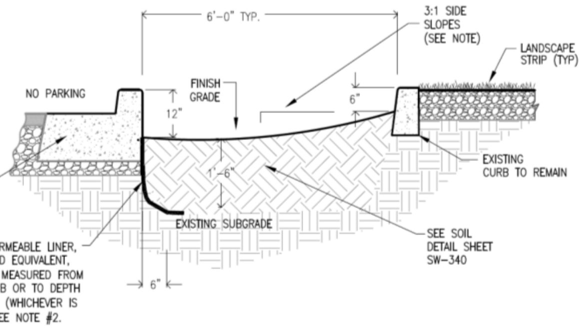
Linear Planter - Large

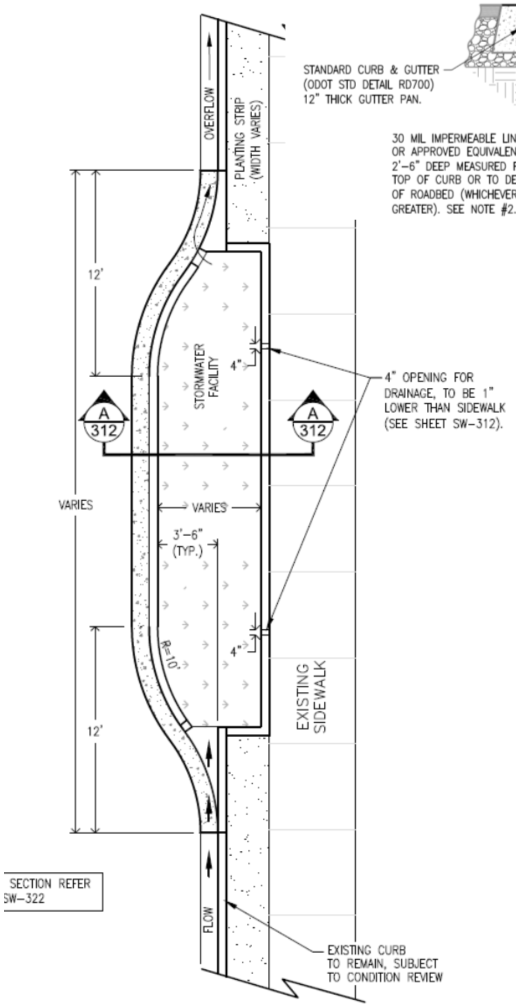


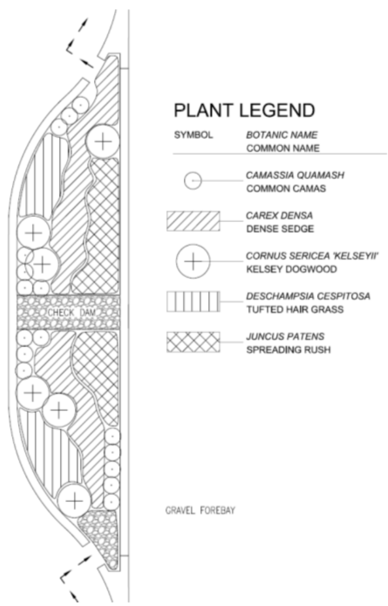
Planter Box Next to Building



Curb Extension





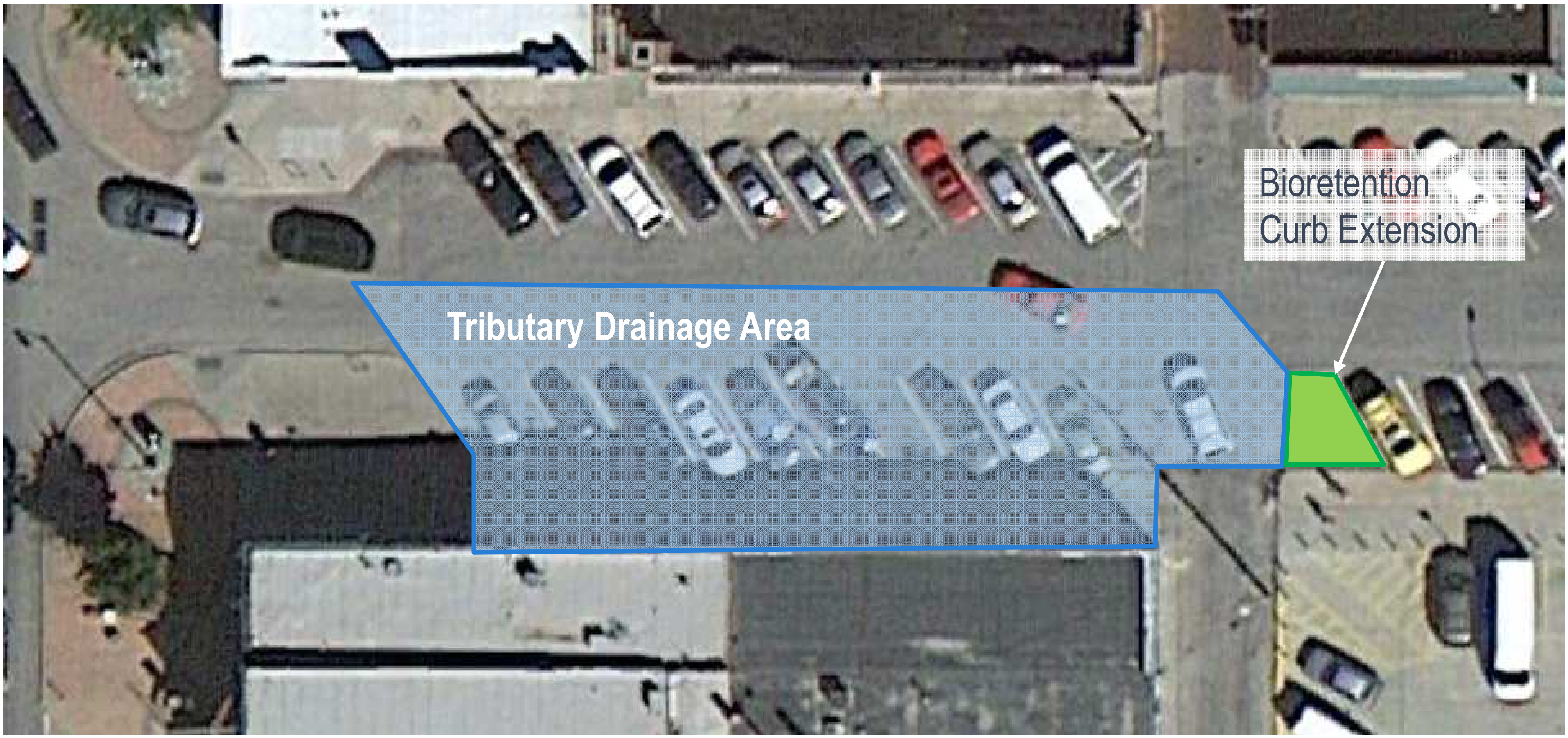


BIORETENTION DETAILS

Now let's look a little closer at the component details

Drainage Area

- Practices are sized for the drainage area
- Know the intended drainage area
- Field changes may necessitate design changes



Storage Volume of Practice

- Drainage area equates to a volume of runoff
- Build practices to meet design volume

Category	% of Design Volume	% of Practices in Category
Severely Undersized	<-25%	28%
Moderately Undersized	-25% to -10%	22%
Adequate	**-10% to 10%**	**17%**
Moderately Oversized	10% to 25%	17%
Severely Oversized	>25%	17%

Assessing the Accuracy of Bioretention Installation in North Carolina (2011) B. Wardynski and W. Hunt.

Inlet

- Sized to capture design flow
- **Location** and **elevation**
- Prevent clogging and sediment accumulation
- Guard against excessive inlet velocities

Pretreatment

- Capture large sediment (*sometimes trash and debris*)
- Prevent erosion
- Level weir wall
- Options
  - Filter strips
  - Grass channels
  - Sumps
  - Hydrodynamic devices
  - Screens and baskets
- Design based on dynamic settling and Stokes Law

Primary Storage Area

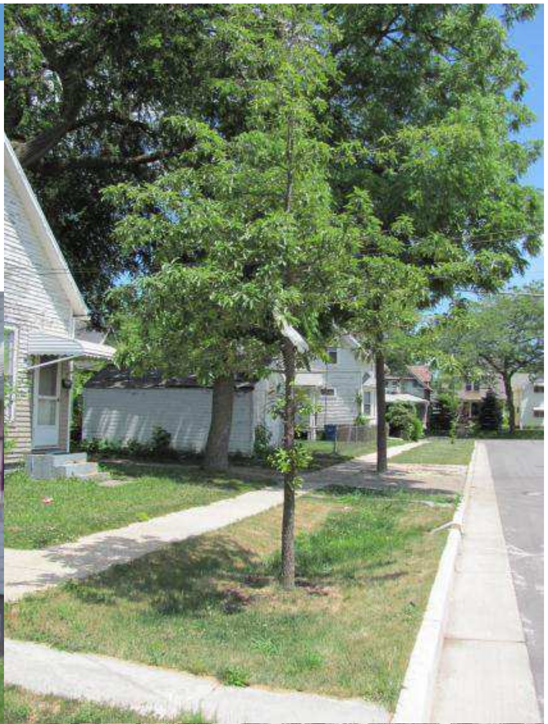
- Level soil surface, i.e. **flat**
- Encourage even infiltration and reduce erosion

Vegetation

- Water Uptake
- Stabilization
- Impeding Flow
- Filtration
- Infiltration
- Nutrient Uptake
- Toxin Uptake
- Pollutant Breakdown

- *Plants for Stormwater Design : Species Selection for the Upper Midwest, by D. Shaw and R. Schmidt, 2003.*
- *Plants for Stormwater Design: Species Selection for the Upper Midwest, Volume II. By D. Shaw, T. Randazzo, H. Johnson, R. Schmidt, B. Ashman, 2007.*
- *Low Impact Development Manual for Michigan: A Design Guide for Implementers and Reviewers, 2008.*

Plant Selection

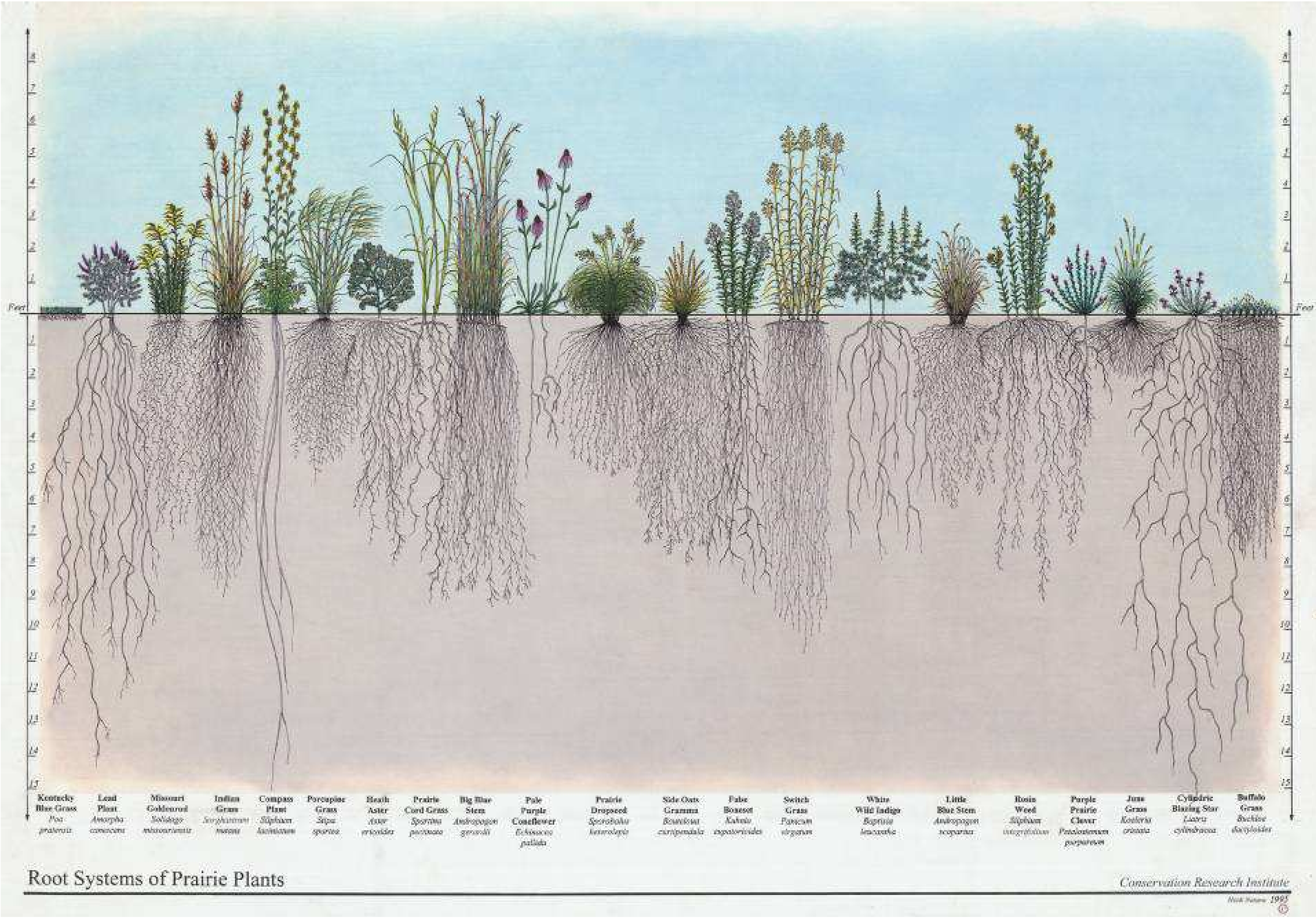



City of Toledo
RECYCLING ONLY

Transpiration Rates of Various Plants

Plant Name	Plant Type	Transpiration Rate
Perennial rye	Lawn grass	0.27 in/day
Alfalfa	Agriculture crop	0.41 in/day
Common reed	Wetland species	0.44 in/day
Great bulrush	Wetland species	0.86 in/day
Sedge	Wetland/prairie species	1.9 in/day
Prairie cordgrass	Prairie species	0.48 in/day
Cottonwood	Tree (2 year old)	2-3.75 gpd/tree
Hybrid poplar	Tree (5 year old)	20-40 gpd/tree
Cottonwood	Tree (mature)	50-350 gpd/tree
Weeping Willow	Tree (mature)	200-800 gpd/tree

Source: Plants for Stormwater Design Volume II by D. Shaw and R. Schmidt (ITRC 2001)



Feet
Kentucky Blue Grass
Lead Plant
Missouri Goldenrod
Indian Grass
Compass Plant
Porcupine Grass
Heath Aster
Prairie Cord Grass
Big Blue Stem
Pale Purple Coneflower
Prairie Dropseed
Side Oats Gramma
False Boneset
Switch Grass
White Wild Indigo
Little Blue Stem
Rosin Weed
Purple Prairie Clover
June Grass
Cylindric Blazing Star
Buffalo Grass
Root Systems of Prairie Plants
Conservation Research Institute

Soil

- A special or engineered soil specified by the particular practice
- Chosen for specific porosity – infiltration of stormwater
- May have special characteristics to treat or absorb nutrients and other pollutants

__Example Mixes__

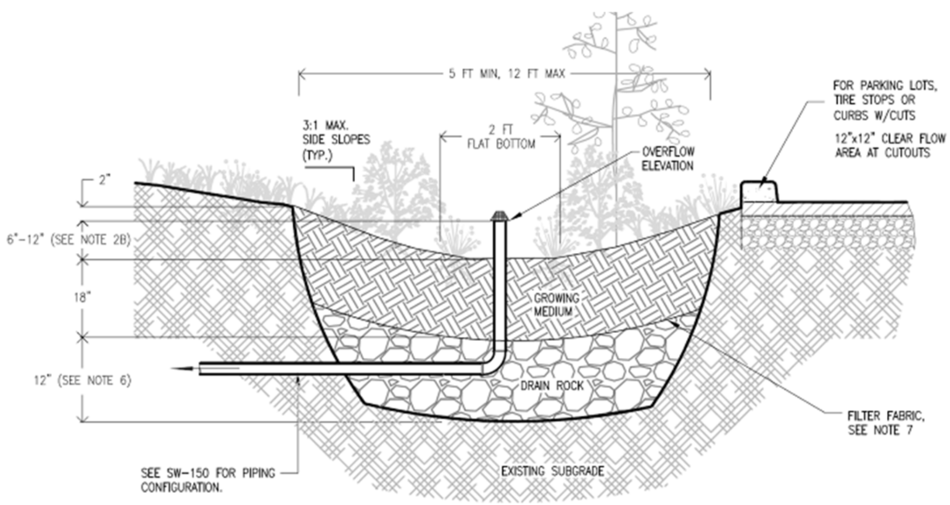
- *Prince Georges Co. MD: 50-60% sand; 20-30% compost; 20-30% topsoil*
- *Minnesota added <5% clay stipulation to PG County mix*
- *NCSU: 85% sand; 12% fines; 3-5% organics*
- *Portland OR: 60-70% sand; 30-40% compost (35-65% organic); particle gradation specified*
- *LID Center: 50% sand; 30% planting soil (50-85% sand, 0-50% silt, 10-20% clay, 1.5 -10% organic); 20% shredded hardwood mulch*

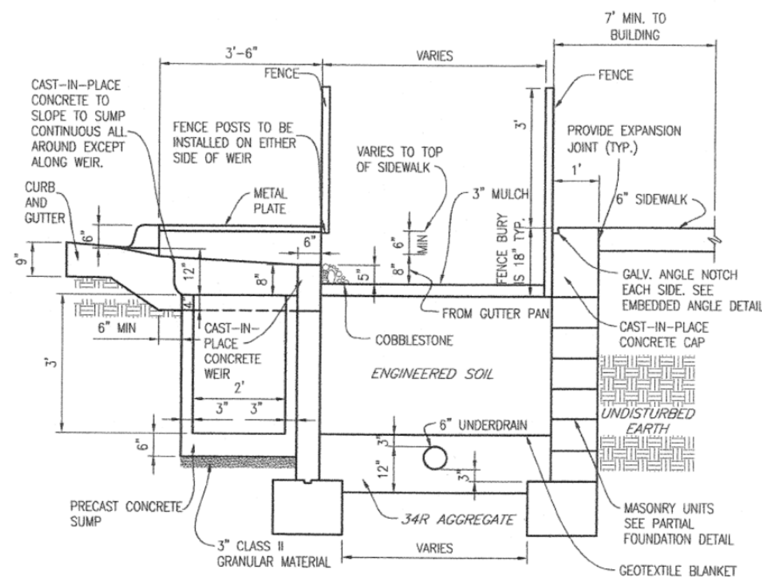
Outlet and Overflow

- Water needs a way to get out
- In-line versus off-line
- **Location** and **elevation**
- Mulch and topsoil should stay in

Supported Sides

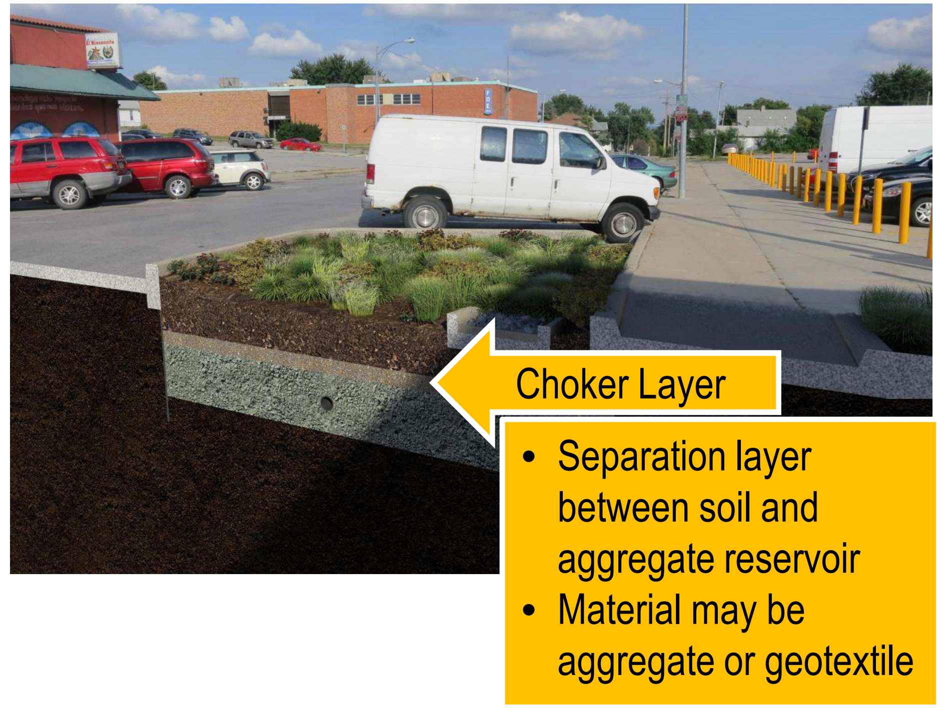
- Compact materials under sidewalk and roads
- Light fluffy soil in bioretention





Filter or Choker Layer

- Challenges
  - Often specified wrong
  - Common failure point of system due to clogging
- Information Needed
  - Required drainage rates (permittivity of filter)
- Geotextiles
  - Filtration
  - Separation
  - Stabilization
  - Permanent Erosion Control
  - Silt Fence
- Aggregate Filter*
  - recommended



- *AASHTO Standard Specification for Geotextile Specification for Highway Application. M 288-06. 2011.*
- *Departments of the Army and the Air Force. Engineering Use of Geotextiles. TM 5-818-8, AFJMAN 32-130. 1995.*
- *Franks, C., A. Davis, and A. Aydilek. Geosynthetic Filters for Water Quality Improvement of Urban Storm Water Runoff. ASCE Journal of Environmental Engineering. 2012.*

Aggregate Storage

- Can be used to increase storage volume
- Open graded aggregate
- Load bearing
- Don't use crushed concrete
  - increases pH for years
  - impedes vegetation growth
  - *Steffes R., Laboratory Study of the Leachate From Crushed Portland Cement Concrete Base Material, Iowa DOT. MLR-96-4. September 1999.*

Underdrain

- Optional based on infiltration capacity of in situ soil
- Purpose to ensure drainage
- 4-inch diameter or larger
- Types
  - Rigid PVC
  - Flexible HDPE
  - SmartDrain (www.smartdrain.com)
- May be paired for redundancy
- Clean-out fittings

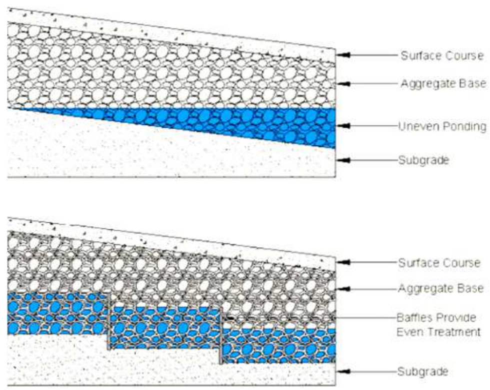
- Outlet is commonly used to control allowable discharge rate
  - Orifice end plate
  - Valve to allow for flow adjustments
- May include upturned elbow to enhance nutrient removal

Sloped Terrain

- Within each cell:
  - Soil and aggregate are level
  - Maximizes storage
  - Promotes infiltration
- Between cells:
  - Separating wall
  - Overflow from one cell cascades to next one downstream
- Can be constructed as continuous swale.
  - System used for conveyance, not just storage
  - Reduced storage volume.
  - Increased likelihood of surface flooding downstream.

The bottom

- Level bottom preferred
- On slopes terrace the bottom or use check dams
- Compact
  - Infrastructure subgrades and bases = **Yes**
  - In situ soil below stormwater practices typically do not (should not) be compacted before placing aggregate and/or soil overtop
  - Aggregate reservoirs = **Yes**
  - Planting soil = **No**
- Loosen and scarify soils
  - Before planting
  - Before placing aggregate or soil layer



COMMON MISTAKES AND LESSONS LEARNED

Details are the difference between success and failure

Details are the difference between success and failure

Common Design Mistakes

- Not understanding the tributary area (size and surface coverage)
- Inadequate inlet
- Sloped surface resulting in reduced infiltration and erosive velocities
- Wrong mulch, floats away and clogs the outlet
- Lack of pretreatment
- No soil tests
- Poor plant selection
- Delayed planting
- Overly complex
- No maintenance plan
- Wrong geotextile specified

HOW WELL DO THEY WORK?

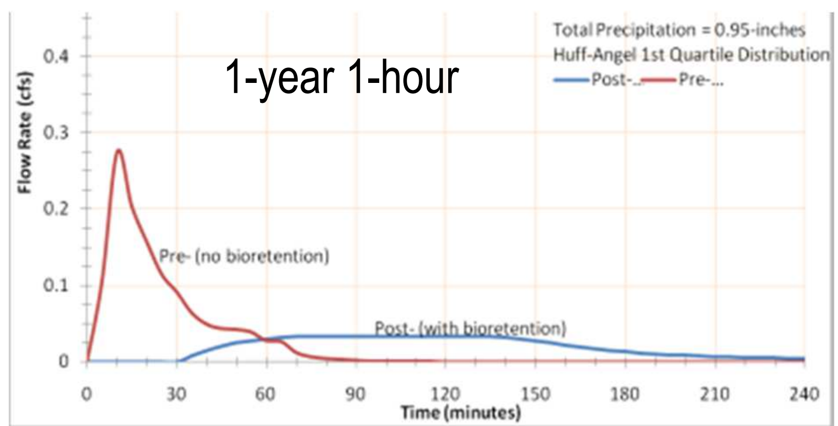
Maywood Ave, Toledo OH

- SFR low income (25% ownership)
- Heavy clay soils
- Engineered system under greenbelt and sidewalk
- Bioswale $150 per linear foot
- 64% average annual volume reduction
- 60 to 70% peak flow reduction
- Eliminated street flooding and basement backups
- Maintenance: turf grass and trees

Michigan Ave, Lansing MI

- Ultra Urban Application
- 4 blocks, 30 bioretentions
- Cost $122/sf ($30/sf without urban constraints)
- 90% Storm Design (+/-)
- 75% decrease in average annual runoff volume

This planter box bioretention treats the 25-year storm event (4.1-inches)



QUESTIONS AND DISCUSSIONS

TETRA TECH

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